Climate Change Vulnerability Index Report

Lomatium serpentinum (Snake Canyon biscuitroot)

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Geographic Area: Washington Heritage Rank: G4/S2

Index Result: Highly Vulnerable Confidence: Very High

Climate Change Vulnerability Index Scores

Section A: Local Climate	**Severity**	**Scope (% of range)**
1. Temperature Severity	>6.0° F (3.3°C) warmer	0
	5.6-6.0° F (3.2-3.3°C) warmer	0
	5.0-5.5° F (2.8-3.1°C) warmer	0
	4.5-5.0° F (2.5-2.7°C) warmer	76.9
	3.9-4.4° F (2.2-2.4°C) warmer	23.1
	<3.9° F (2.2°C) warmer	0
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	0
	-0.074 to -0.096	61.5
	-0.051 to -0.073	23.1
	-0.028 to -0.050	15.4
	>-0.028	0
Section B: Indirect Exposure to Climate Change		**Effect on Vulnerability**
1. Sea level rise		Neutral
2a. Distribution relative to natural barriers		Neutral
2b. Distribution relative to anthropogenic barriers		Somewhat Increase
3. Impacts from climate change mitigation		Neutral
Section C: Sensitivity and Adaptive Capacity		
1. Dispersal and movements		Somewhat Increase/Increase
2ai Change in historical thermal niche		Neutral
2aii. Change in physiological thermal niche		Somewhat Increase
2bi. Changes in historical hydrological niche		Somewhat Increase
2bii. Changes in physiological hydrological niche		Somewhat Increase
2c. Dependence on specific disturbance regime		Somewhat Increase
2d. Dependence on ice or snow-covered habitats		Neutral
3. Restricted to uncommon landscape/geological features		Neutral
4a. Dependence on others species to generate required habitat		Neutral
4b. Dietary versatility		Not Applicable
4c. Pollinator versatility		Unknown
4d. Dependence on other species for propagule dispersal		Neutral
4e. Sensitivity to pathogens or natural enemies		Neutral
4f. Sensitivity to competition from native or non-native species		Neutral/Somewhat Increase
4g. Forms part of an interspecific interaction not covered above		Neutral
5a. Measured genetic diversity		Increase
5b. Genetic bottlenecks		Unknown

5c. Reproductive system	Neutral
6. Phenological response to changing seasonal and precipitation dynamics	Neutral
Section D: Documented or Modeled Response	
D1. Documented response to recent climate change	Neutral/Somewhat Increase
D2. Modeled future (2050) change in population or range size	Unknown
D3. Overlap of modeled future (2050) range with current range	Unknown
D4. Occurrence of protected areas in modeled future (2050) distribution	Unknown

Section A: Exposure to Local Climate Change

A1. Temperature: Ten of the 13 occurrences of *Lomatium serpentinum* in southeastern Washington (76.9%) occur in areas with a projected temperature increase of 4.5-5.0° F (Figure

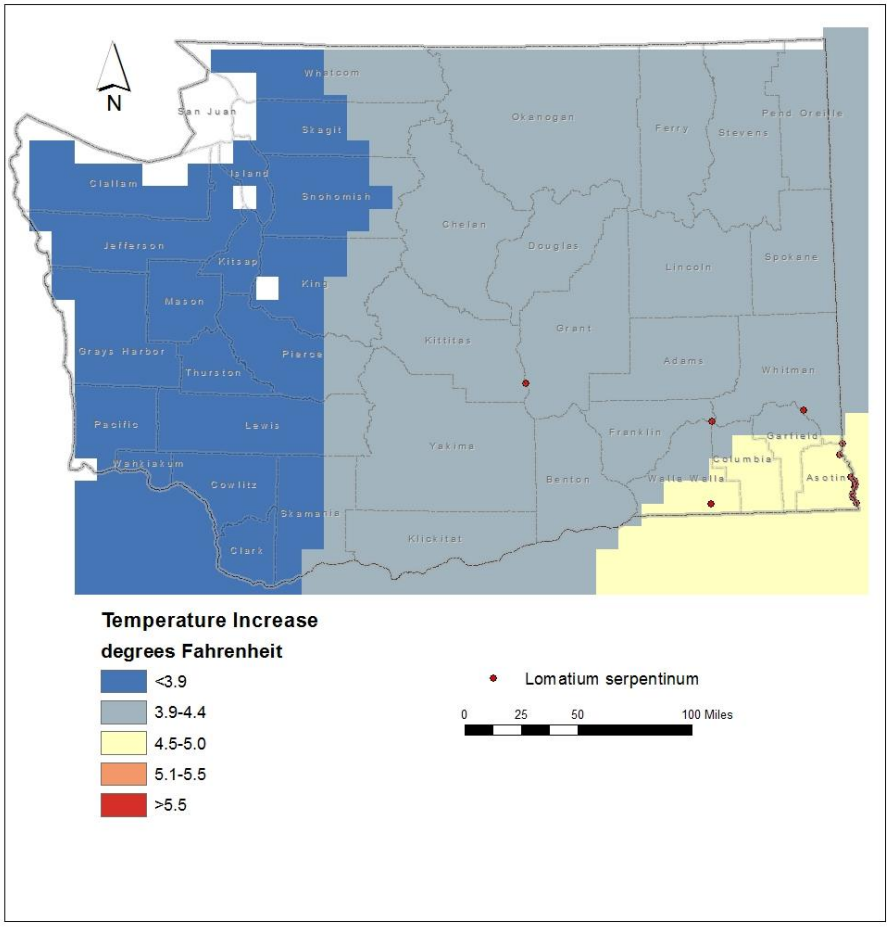

Figure 1. Exposure of *Lomatium serpentinum* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

1). Three historical records (23.1%) from the Columbia Plateau are from areas with a predicted increased of 3.9-4.4˚ F (Figure 1). A questionable recent report from the East Cascades in Yakima County is excluded from this analysis.

A2. Hamon AET:PET Moisture Metric: Eight of 13 Washington occurrences of *Lomatium serpentinum* (61.5%) are found in areas with a projected decrease in available moisture (as measured by the ratio of actual to potential evapotranspiration) in the range of -0.074 to -0.096 (Figure 2). Three historical occurrences (23.1%) are from areas with a predicted decrease in the range of -0.051 to -0.073. Two other historical occurrences (15.4%) are from areas with a projected decrease of -0.028 to -0.050 (Figure 2).

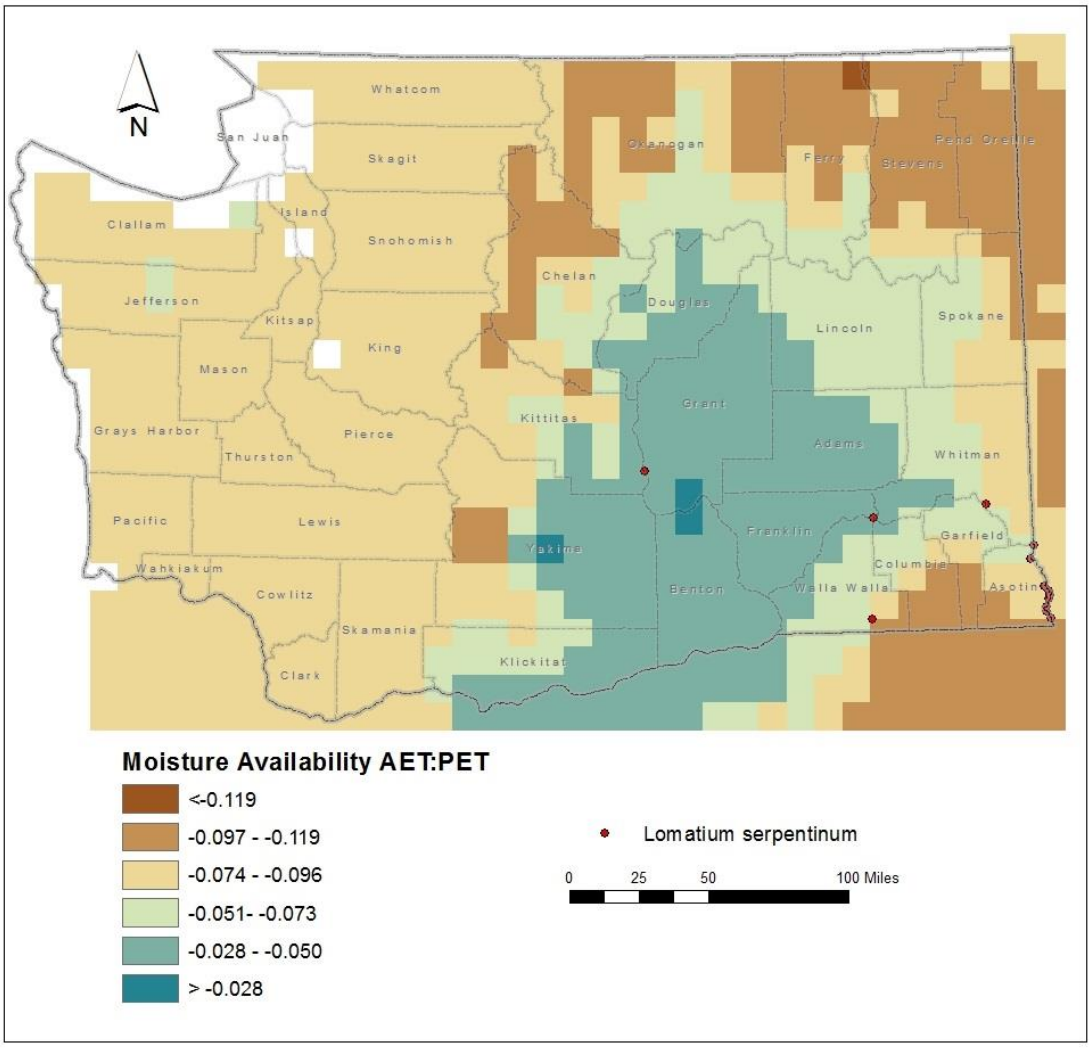

Figure 2. Exposure of *Lomatium serpentinum* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Lomatium serpentinum* are found at 750-1200 feet (230-365 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral.
In Washington, *Lomatium serpentinum* is found in rock crevices, basalt ledges, and talus along river channels (above the high water zone) and old floodplains (Camp and Gamon 2011; Washington Natural Heritage Program 2021). This habitat is a component of the Intermountain Basin Cliff and Canyon ecological system (Rocchio and Crawford 2015). Individual populations are separated by 1.2-83 miles 2.6-133 km). Potential habitat may occur along the Snake and Columbia rivers and their main tributaries, but is unlikely to be present in areas between. The river corridors provide a potential route for dispersal, but intervening upland areas present a barrier.

B2b. Anthropogenic barriers: Somewhat Increase.
Much of the riverbank habitat of *Lomatium serpentinum* in Washington has been altered by construction of reservoirs downstream of Clarkston or conversion to agricultural lands (Camp and Gamon 2011), which now present a significant barrier to dispersal.

B3. Predicted impacts of land use changes from climate change mitigation: Neutral.

Section C: Sensitivity and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase/Increase.
Lomatium serpentinum produces dry, oblong fruits (schizocarps) that split at maturity into two one-seeded segments. Each fruit segment has slightly raised ribs on the surface and broad, membranous wings along the margins. The winged fruits could travel short distances by wind. Fruit segments might also travel longer distances by water. Most *Lomatium* species have poor dispersal ability (less than 100 meters) which may account for their unusually high degree of endemism in western North America (Marisco and Hellman 2009).

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Lomatium serpentinum* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All 13 extant and historical occurrences (100%) are found in areas that have experienced average (57.1-77˚F/31.8-43.0˚C) temperature variation during the past 50 years and are considered at neutral risk from climate change (Young et al. 2016).

C2aii. Physiological thermal niche: Somewhat Increase.
The river channel habitat of *Lomatium serpentinum* is a cold air drainage during the early spring growing season. Higher temperatures from projected climate change could make these sites warmer than they are presently.

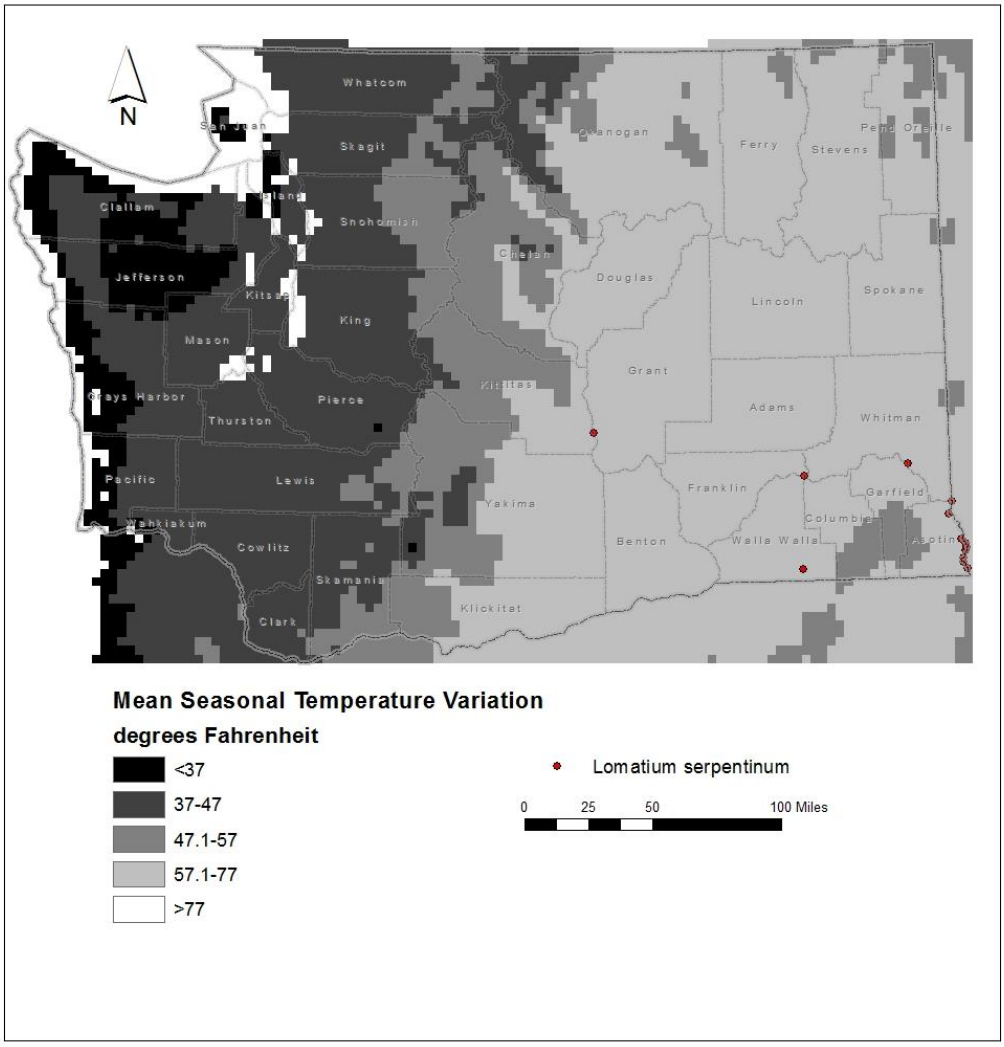

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Lomatium serpentinum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Somewhat Increase.
Twelve of the 13 populations of *Lomatium serpentinum* in Washington (92.3%) are found in areas that have experienced slightly lower than average (11-20 inches/255-508 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), these occurrences are at somewhat increased vulnerability from climate change. One historical occurrence from central Washington is from an area with small precipitation changes (4-10 inches/100-254 mm) over the same period and is at increased risk from climate change.

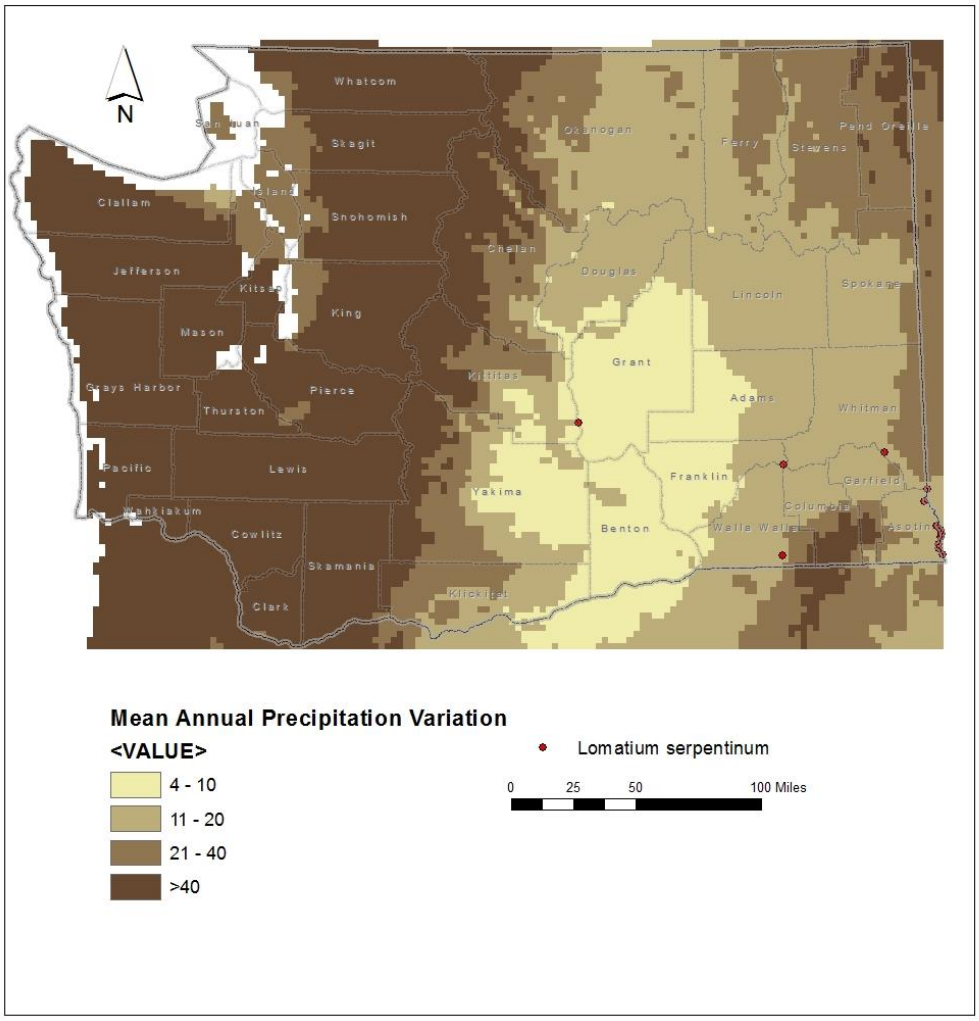

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Lomatium serpentinum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
This species occurs in sparsely vegetated basalt talus, boulders, and rock outcrops above the high water zone of rivers in eastern Washington. Rising temperatures associated with projected climate change could affect water levels, especially during summer. Changes in the amount or timing of precipitation could also make these sites drier, resulting in a shift in dominance from vascular plants to more drought-resistant lichens (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Somewhat Increase.
Lomatium serpentinum may be dependent on periodic disturbances, such as flooding, to maintain its sparsely vegetated basalt ledge, boulder, and talus habitat in river valleys. Reduction in precipitation or upstream snowmelt and increases in temperature could reduce total water flows or the intensity of spring flooding events. In the absence of disturbance, total plant cover of shrubs, trees, and herbaceous species is likely to increase and displace species adapted to low competition (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Neutral.
Lomatium serpentinum occurs in areas of low accumulation of snow. Reduced snowpack or changes in the timing of snowmelt in the montane headwaters of the Snake River would result in lower flow levels and reduced disturbance (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
Lomatium serpentinum is restricted to Miocene-age outcrops of the Grande Ronde and Wanapum Basalt (Washington Division of Geology and Earth Resources 2016). One population has also been reported from limestone substrates in extreme southeast Washington, a formation limited to the Lime Hill area. These formations are widely distributed in the Columbia Basin. Reports from granite substrates (Soltis et al. 1997) are probably erroneous.

C4a. Dependence on other species to generate required habitat: Neutral.
The riverine volcanic bedrock, boulder, and talus habitat of *Lomatium serpentinum* is maintained primarily by natural abiotic processes rather than by interactions with other species.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
The specific pollinators of *Lomatium serpentinum* are not known. Other *Lomatium* species are pollinated by a variety of solitary bees, syrphid flies, tachinid flies, muscid flies, bee flies, and beetles (Schlessman 1982).

C4d. Dependence on other species for propagule dispersal: Neutral.
The dry, one-seeded fruits of *Lomatium serpentinum* are dispersed primarily by wind, gravity, water, or other passive means. The species is not dependent on animals for transport.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Due to its rocky habitat, this species is not easily grazed by livestock or large ungulates. Impacts from smaller herbivores (insects and rodents) are poorly known, but probably low.

C4f. Sensitivity to competition from native or non-native species: Neutral/Somewhat Increase.
The rocky sites occupied by *Lomatium serpentinum* have low vegetative cover, which may be maintained in part by periodic disturbance by flooding along the Snake or Columbia rivers. Under projected climate change, river flows may be reduced and the timing or severity of floods may be changed, making basalt boulder and talus areas more susceptible to competition from trees, shrubs, or herbaceous species. Long term drought conditions, however, may shift species dominance on rock sites from vascular plants to hardier lichens (Rocchio and Ramm-Granberg 2017).

C4g. Forms part of an interspecific interaction not covered above: Neutral.
Does not require an interspecific interaction.

C5a. Measured genetic variation: Increase.
Soltis et al. (1997) sampled the genetic variability of *Lomatium serpentinum* and several other rare and common *Lomatium* species. They found that the rare species (*L. serpentinum, L. rollinsii,* and *L. laevigatum* – all edaphic endemics in the Snake and Columbia River drainages) maintained very low levels of allozymic polymorphism within and between populations, while widespread species (*L. dissectum, L. grayi*, and *L. triternatum*) had significantly higher genetic variability. The low variability of *L. serpentinum* may be attributed to its recent evolutionary origin, which has not allowed sufficient time for new mutations to accumulate (Soltis et al. 1997).

C5b. Genetic bottlenecks: Unknown.
Soltis et al. (1997) suggest that past genetic bottlenecks could contribute to the low overall genetic diversity of *Lomatium serpentinum* and other Snake and Columbia River endemic *Lomatium* species.

C5c. Reproductive System: Neutral.
Like many other *Lomatium* species, *L. serpentinum* is probably primarily an outcrosser due to andromonoecy (hermaphroditic and functionally staminate flowers produced in different parts of the same inflorescence and maturing at different times) (Schlessman 1982).

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on flowering dates from specimens in the Consortium of Pacific Northwest herbaria website, no major changes have been detected in phenology since the species was first documented in Washington in the 1920s.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral/Somewhat Increase.
The present distribution of *Lomatium serpentinum* has contracted significantly during the past 40 years, with 8 of 13 populations considered historical (61.5%). This includes all of the known occurrences from the Columbia River and the lower reaches of the Snake River (outside of Asotin County) (Washington Natural Heritage Program 2021). If the populations are extirpated, the cause may be habitat loss due to reservoir and agricultural development, although perhaps influenced by climate change.

D2. Modeled future (2050) change in population or range size: Unknown

D3. Overlap of modeled future (2050) range with current range: Unknown

D4. Occurrence of protected areas in modeled future (2050) distribution: Unknown

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